

White Paper Report

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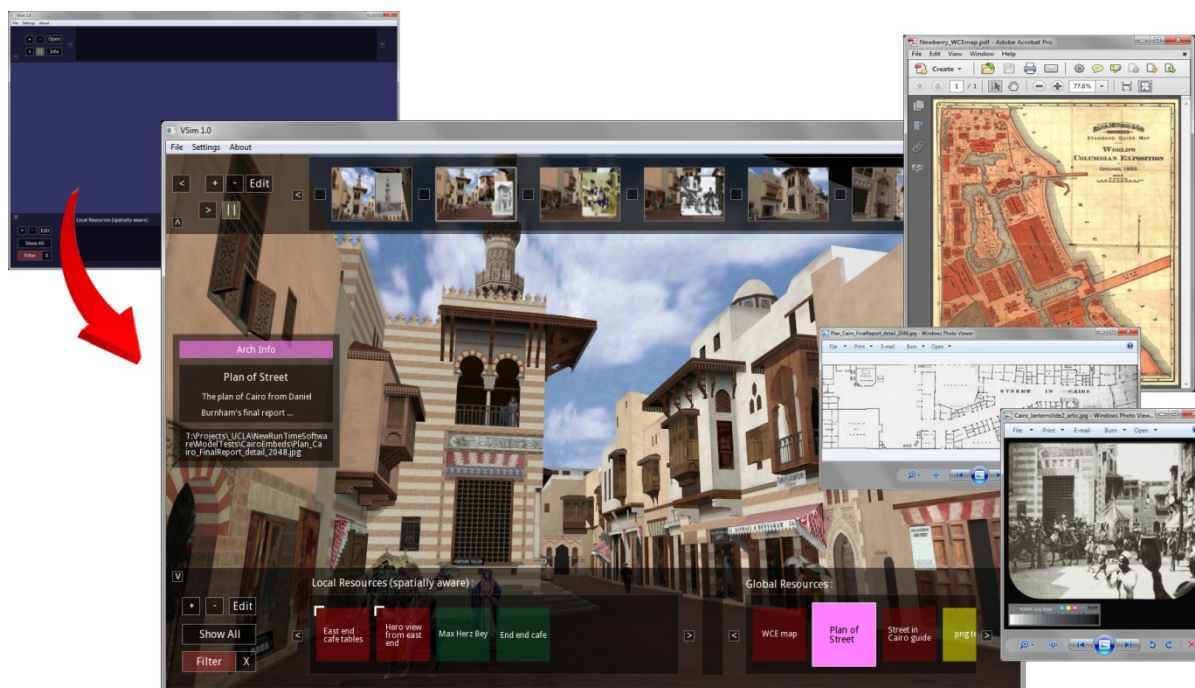
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The VSim prototype is a flexible piece of software for interacting with 3D content in educational settings. At first launch, the software appears deceptively simple (upper left image), but it facilitates sophisticated interactions with academically generated real-time models. The VSim screenshot above shows the Street in Cairo installation on the Midway Plaisance from the Urban Simulation Team's reconstruction of Chicago's World's Columbian Exposition of 1893, an example of a real-time model being built at UCLA and intended for educational use. The thumbnails across the top of the simulation window show a portion of a linear narrative describing the space. Embedded primary and secondary resources, websites, and annotations can be accessed from the bar along the bottom of the simulation window. The different colors refer to different categories of information (e.g., photographs, renderings, architectural drawings, and ephemera). At right are examples of three launched resources related to the Street in Cairo: a map of the exposition from the Newberry Library, a plan of the Street in Cairo from Daniel H. Burnham's final report, and a lantern slide from Ryerson and Burnham Archives at the Art Institute of Chicago.

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Software interface for real-time exploration and educational use of three-dimensional computer models of historic urban environments (VSim)

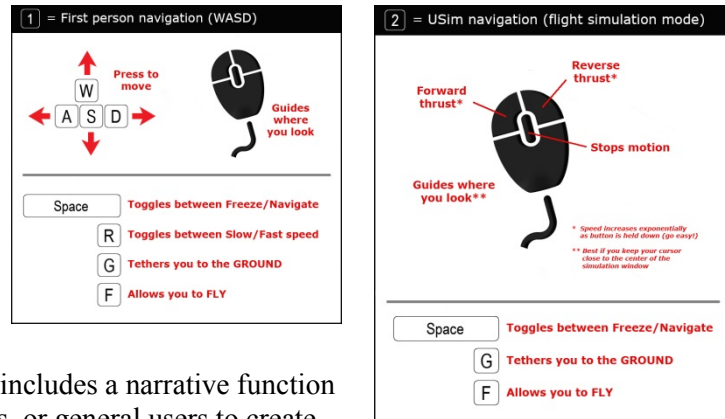
Project Co-Principal Investigators: Lisa M. Snyder and Scott Friedman
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VSim 1.0

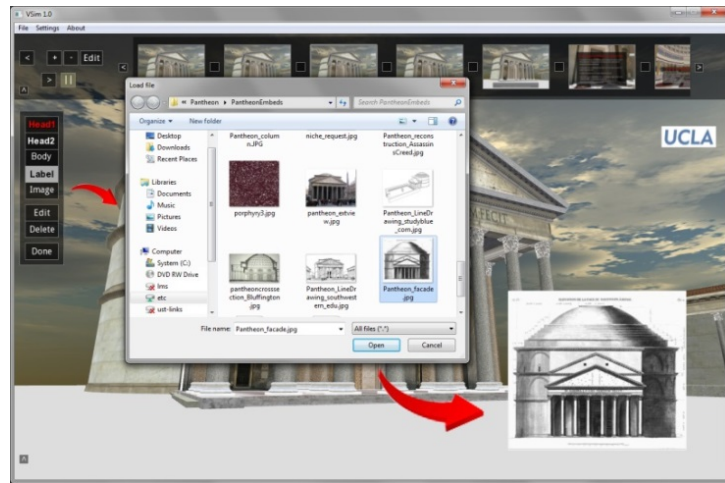
Funding from the NEH was used to develop a generalizable and extensible prototype for software that allows real-time exploration of highly detailed, three-dimensional computer models of historic urban environments in both formal and informal educational settings. The goal of this proof-of-concept effort was to create the initial framework for software that will give scholars and educators mechanisms to explore, annotate, craft narratives, and build arguments within the 3D space – in essence, facilitating the creation of virtual learning environments that can be broadly disseminated to educators and learners across grade levels and humanities disciplines.

This prototype software (VSim 1.0) was released in June 2013 and both Windows- and Mac-compatible versions are available for download at <https://idre.ucla.edu/gis-visualization/vsim>. In

addition to the software, the website includes downloads for a sample model of the Pantheon created by UCLA's Experiential Technologies Center, user guides, and links to tutorials and presentations that feature the software. The software allows three modes of navigation (WASD gamer-style interaction, flight simulation, and object rotation; graphics describing the first two styles are shown at right). It includes a narrative function that allows content creators, educators, or general users to create, play, and share linear presentations. These narratives are akin to PowerPoint presentations, but in 3D space where the individual nodes (or slides) can be overlaid with text and imagery. (The illustration below illustrates the process to add an image to a narrative node.)



The software also includes a mechanism to embed spatially aware resources into the virtual space. These embedded resources can provide users access to annotations, multi-media files, and websites related to the modeled environment. (These features can be seen in the illustration on the previous page; the thumbnails of a linear narrative are shown along the top of the simulation window, links to embedded resources are shown along the bottom, and three 'launched' resources are shown at right.)



But what does all of that actually mean? How and why would one use such software? And why is that desirable or important?

To answer those questions, one must consider the user:

- For the **creator** of the computer reconstruction of the World's Columbian Exposition model illustrated on the previous page, VSim fulfills three critical needs. First, it provides an interface for navigating the virtual environment and examining the computer model. This real-time interaction provides immediate and direct feedback on the work in progress. VSim also provides a mechanism for packaging and distributing the virtual model. Through the 'Export model' feature, a 'read-only' copy of the model can be created and shared with colleagues. Finally, VSim provides a mechanism for marking up the virtual environment – the 3D equivalent of annotating a piece of significant scholarship for peer review.
- For an **educator** interested in using the World's Columbian Exposition model, VSim is the software that can bring the experience of the virtual exposition to the classroom. Presentations about the exposition can be simply created with the narrative feature and

incorporated into the day's lesson plan or used as the basis for a student assignment. The model can also be used as a site of secondary scholarship to inform new arguments about the exposition.

- For the *student*, VSim enables real-time exploration of the virtual environment, either as an integrated classroom experience or as the basis for an assignment. Moving through the reconstruction model of the Street in Cairo, for example, students are presented with links to spatially aware resources that will help them build knowledge about the exposition. At the Dancing Theater, one link might take them to a Thomas Edison film of an exotic dancer at the Library of Congress, while another to a lantern slide of the Street at the Burnham Ryerson Archives at the Art Institute of Chicago. Tasked with creating a linear narrative or assembling a group of resources to be embedded into the exposition model directly engages the student by involving them in the learning process.

Sound desirable and important? The project team thinks so. Our test users thus far are convinced. But there's much work to be done before the types of interactions with virtual environments described above are standard in academia. The following discussion considers the lessons learned during the fulfillment of the now-closed NEH Start Up grant to develop the VSim prototype and their impact on future work.

Background

The original VSim proposal sprang out of this author's 2003 PhD dissertation on the use of interactive computer models for the study and teaching of historic urban environments. It was also informed by the ongoing research on 3D technologies at UCLA. Beginning in the early 1990s, under the direction of Bill Jepson, the Urban Simulation Team at UCLA was creating highly detailed real-time models of Los Angeles, the UCLA campus, and historic reconstructions of sites like Trajan's Forum, Jerusalem's Temple Mount, and the World's Columbian Exposition of 1893. In the late 1990s, Bernie Frischer (Classics) and Diane Favro (Architecture and Urban Design) established the Cultural Virtual Reality Lab (CVRLab) to focus on cultural heritage reconstructions beginning with the Roman Forum. In 2004, Favro established the Experiential Technologies Center to continue the UCLA-based work of the CVRLab.

The availability of tools and software packages for working with 3D content has sparked an explosion of computer reconstruction projects over the past fifteen years and academic interest in virtual reality continues to grow.¹ Platforms like Google Earth and Second Life have escalated interest in virtual 3D worlds, but are targeted towards the general public, not an academic audience. In this hive of activity, the missing piece was translational software for using and re-purposing 3D content in the classroom. Hence VSim. The design of VSim was grounded on three basic presuppositions. First, that academically generated, highly detailed interactive 3D computer models of historic urban spaces offer distinct advantages over static imagery for teaching and learning about the built environment. Second, that attempts to integrate such content into the classroom should accommodate the prevailing teaching and learning methods of disciplines focused on the built environment. And, finally, that it should be possible to re-purpose existing content for use in both formal and informal educational settings.

This focus on classroom use dictated a number of specific design choices. With a nod to Larry Cuban and his book *Teachers and machines: the classroom use of technology since 1920*, the

¹ A keyword search of NEH's funded projects query form supports this assessment with a broad mix of 3D projects focused on archaeology, cultural heritage, gaming, model building, and user interaction.

development team's keywords were simplicity, versatility, and efficiency.² We worked to package a very complex set of interactions with 3D content into a simple, non-threatening framework for integrating virtual environments into the classroom – no small feat. We stripped the graphics down to simple familiar icons that mimic operations in commonly used software packages and minimized the menus required for interaction. To encourage use, the software had to meet a very low technological threshold – our mantra was simple, simple, simple – and we added the COLLADA loader to accommodate simple projects built in low-cost or free modeling packages like Trimble's Sketch Up as well as high-end academic content built in sophisticated modeling packages like Autodesk's 3ds Max. Our goal was a versatile framework that catered to discovery learning, but was flexible enough to be used for teacher-centered presentations (i.e., lectures), student-centered activities (i.e., assignments), and a wide array of learning objectives. The power of this versatility is directly proportional to its efficiency: content creators, educators, or users can elect to use the navigation, narrative, and embedded resource features in innovative combinations to support the construction of knowledge as is appropriate for their content.

Reflections on the process (part summative evaluation, part formative)

All in all, the project team met the objectives of the original Start Up grant proposal. Windows- and Mac-compatible versions of the VSim prototype (version 1.0) were released in June 2013 along with appropriate support documentation and sample files. These files are freely available for download at <https://idre.ucla.edu/gis-visualization/vsim>.

While ultimately successful, the process was not without its challenges, and the arc of the development cycle foregrounded a number of issues and points for discussion related to pedagogical applications of 3D work. The reflections offered below describe some of the choices made by the development team and how they impact or were informed by the larger vision for the project – unchanged from the original Start Up proposal:

“This prototype is one piece of a larger project to facilitate the educational use of three-dimensional computer models of historic urban environments across the humanities. The educational promise of digital computer environments has yet to be realized, largely because **past efforts have focused on the short-term constructivist benefits** of the process for the academic development team. As a result, a great deal of content has been developed but is unavailable for general use. The larger project **vision is to leverage existing and new modeling work for broad educational use** by facilitating submission of scholar-created content to a project repository,³ allowing the aggregation of multimedia support material, and providing an administrative front end that would include incentives for contributors to share their data. In addition to providing them access to the open source software, this administrative front end would ensure that content contributors are given proper credit for their work, and provide them a mechanism to control how they distribute their content and charge for their work (if desired).”⁴

² Larry Cuban's conclusion about instructional technology is that it often fails to gain acceptance because “the simplicity, versatility, and efficiency of ... aids such as the textbook and chalkboard in coping with problems arising from the complicated realities of classroom instruction far exceed the limited benefits extracted from using machines.” (1986, 59)

³ This type of content repository has precedent in the ‘Great Buildings’ series created in the mid-1990s. It was also a central element of Snyder's doctoral dissertation (UCLA, 2003), and Frischer's 2005 proposal for archiving computer models of cultural heritage sites. [The footnote in the original proposal continues with details about 3D projects at UCLA.]

⁴ This is an important feature in that it would allow content providers the opportunity to generate a revenue stream to support ongoing development and help to make large-scale modeling projects self-sustaining.

Completion of the prototype software is the first step towards this long-term vision. Yes, we consider our proof-of-concept a success, but a provisional one in the arc of the larger project where success requires: 1) stable (and complete) software for interaction with 3D content that meets the needs of in-service educators, 2) a critical mass of academically appropriate 3D content available for pedagogical use, and 3) a repository for dissemination that helps to provide sustainable funding for ongoing content and software development. What will it take to get there? Commitment. Energy. Time. Talent. Coordination. Marketing. Buy-in. Funding. Is it possible? Yes, but there are significant challenges and issues to be considered and addressed:

So much technology, so little time (and money). The idea of a VSim-based project repository is sound, but academic 3D work has yet to coalesce into a standard by any definition. It is readily apparent from a review of the 3DVisA Index of 3D Projects maintained at King's College London that much of this work is being developed as one-offs, constructed for a specific purpose or with a specific set of tools that may or may not remain viable after the life of the project.⁵ Teaching and learning resources generated from the computer models are common (e.g., animated videos and static images), but some projects have faded into memory, no longer available in any form to the academic community.⁶ The absence of a standard toolkit for the creation and dissemination of academic 3D work could be read as both an opportunity and a problem. The freedom to choose technologies and workflows based on the research objectives of the PI and project is offset by the pressure to choose from a dizzying array of options for building 3D content,⁷ online virtual worlds and game engines that may (or may not) be appropriate for an academic endeavor,⁸ and opportunities for dissemination (web, mobile, etc.) that may or may not be sustainable in the long run. VSim was intended to be a part of that standard toolkit and to provide an after-life for these one-off projects, but this will be a challenge until the software is solid enough to be widely adopted and the technical choices for developing 3D content standardize output.

To code or not to code. Considering the plethora of available tools and software platforms, the decision to build a tool versus using an off-the-shelf tool was made with caution. Aligning with a for-profit company may have been easier in the short-term because it would have allowed the project team to leverage existing tools and resources, but such associations becomes problematic when the for-profit venture's market share evaporates or their costs escalate. Consider SecondLife and the number of academic projects, like the Theatron3 project, that have been abandoned because of the ongoing costs associated with 'renting' virtual real estate.⁹ But both options involve risk and the potential for long-term sustainability problems. Anyone working with technology has encountered these issues ("no one's using ___ anymore," "___ is so much easier to use," and "can it run on my four-year-old laptop?"). The VSim team made the decision to build new run-time software because the available software platforms didn't have the desired mix of features for the proposed educational use: the ability to create linear narratives and embedded resources, the ability to interact with highly detailed, large-scale models, and the choice of multiple modes of navigation. This decision to build home-grown software rather than

⁵ See <http://3dvisa.cch.kcl.ac.uk/>

⁶ An interactive reconstruction of the Parthenon, for example, was developed at Oxford under a program that has since been dissolved; the index notes that the resource status is 'unknown.'

<http://3dvisa.cch.kcl.ac.uk/project52.html>

⁷ <http://www.3ders.org/3d-software/3d-software-list.html>, <http://features.en.softonic.com/top-10-3d-modelling-applications-on-pc>, http://en.wikipedia.org/wiki/3D_computer_graphics_software

⁸ <http://www.virtualworldsreview.com/info/categories.shtml>, <http://arianeb.com/more3Dworlds.htm>, <http://www.opencolleges.edu.au/informed/features/top-20-uses-of-virtual-worlds-in-education/>, http://www.silversprite.com/?page_id=353

⁹ The website for the Theatron3 project opens with the announcement that the project has been "discontinued due to lack of funds needed to maintain the subscription to Linden Labs (Second Life)." <http://cms.cch.kcl.ac.uk/theatron/>.

adopting (or adapting) an existing tool provides the project team some modicum of control over the software's long-term viability, but any change in hardware, operating systems, tools, and support for the various libraries and plug-ins upon which the software relies will introduce the likelihood for problems with obsolescence and compatibility.

Talent and skills trump all, but at a price. Having committed to building new software, the project team also had to commit to the programmers hired for the task. Locating and retaining skilled team members is going to be a challenge for any project, but the stakes are higher when the development cycle relies solely on student workers with specialized software knowledge. Computer science PhD student Eduardo Poyart was the initial hire on the project and he worked closely with PI Snyder on the specifications for the software. Poyart generated the early working releases and was responsible for the framework of VSim's narrative feature. Eventually, two additional computer science students joined the team: PhD student Jingyi [Franklin] Fang was responsible for the framework for the embedded resource function and MS student Xinli Cai worked on various elements of the prototype and was responsible for the branding feature.

Over the arc of the project, the three programmers were routinely offered opportunities for campus positions that included fee remissions – an impossibility for small grants like those in the Start Up program. (At UCLA, fee remissions equate to almost \$5,000 for residents and almost \$10,000 for nonresidents *per quarter*. For a grant with direct costs hovering in the \$38,000 range, this is untenable.) Encouraged by their academic advisors, the student programmers also sought out and were offered desirable summer internships with major employers including nVidia and Google, further cutting into time available for VSim development. For the VSim team, the options were to hire less skilled students and lose time to a steep learning curve or work piecemeal with the existing team to complete the code. The decision to work with the existing students was made and they wrote the software between sessions and during quarters when they didn't have opportunities for teaching assistantships and graduate student researcher positions. As a result of this commitment to the student programmers and their ever-changing schedules, the VSim team had to request two no-cost extensions. The lesson to be learned is simple: any future grant proposals that include student workers in key software development positions must also include funding for fee remissions.

Where's my avatar? VSim was specifically constructed for teaching and learning about historic urban environments and was designed to respond to the teaching and learning methods that dominate disciplines involved in such studies. Where the point is to build knowledge about the modeled environment, VSim addresses the needs of both expert and novice. When modeling virtual environments, advanced researchers are calling into play their years of experience to make decisions about the built form and using the creation process as a way to deepen their knowledge about the space in question; students interacting with the resultant virtual environment embedded with a full suite of resources and annotations that explain these decisions are building knowledge about both the modeled environment and the analytic process used in its creation. This focus on the environment *per se* may limit VSim's usefulness for projects with broader requirements (e.g., when social interactions or character animations are critical), but VSim was never intended to replicate the functionality of online virtual world and game engines. Future development could consider the pedagogical desirability of new features, but only after careful consideration of the desired learning and research objectives associated with them and a review of other available platforms to avoid redundancy.

Simplify, simplify, simplify. One of the greatest challenges encountered during the VSim development was taking complex interactions within a virtual world and simplifying them for use by in-service educators. The project goal was not to produce software for tech savvy graduate students and researchers – although VSim can address their requirements – but rather to produce

software that would be non-threatening and encourage the use of 3D content in the classroom. The basic graphic design was also a specific attempt to overcome instructor resistance to technology in the classroom – there aren't many choices to confuse the novice user, and the screened narrative and embedded resource bars can be collapsed to remove distractions from the virtual environment. By design, VSim operates on many levels to accommodate users as they become more confident in the software and their navigation skills. For example, if narratives are available for the environment they've loaded, a novice user merely has to select the desired narrative, and press '>' to begin interacting with the content; pressing the 'p' on the keyboard allows them to toggle between pausing and playing the narrative. More advanced users can choose to build their own narratives, or break from an existing narrative to navigate through the virtual environment at will. Embedded resources can be ignored or launched at will. The mechanisms to build a narrative, add narrative nodes, adjust timing, and add overlay content were similarly stripped to their bare essentials. Using VSim from a content creator perspective is more complicated, but users at that level are likely to be comfortable navigating through virtual environments. For these uses, the task of building narratives, adding embedded resources, and exporting files is trivial.

Where's the fun in that? The push to 'gamify' digital content, especially 3D content, is pervasive. But is it desirable? What learning objectives are met within a cultural heritage visualization when interaction is focused on a game set within that environment? What would students learn about the World's Columbian Exposition if their interaction with the reconstruction model under development at UCLA was focused on trying to catch a virtual H.H. Holmes within the virtual fairgrounds?¹⁰ And even if they learned something ("It was big ... and white"), would that meet any learning objectives set out for the study of the environment? An argument against this type of incidental learning is efficiency; few classrooms have the luxury of time to spend hours within a game *hoping* that learning will occur. A better pedagogical alternative is a targeted experience that focuses on key learning objectives identified by the instructor. While VSim itself does not explicitly support the creation of games within the virtual spaces, opportunities for quests, tasks, rewards, and incentives all exist in the current prototype. Central to the design was the idea that the embedded resources would spark students' intrinsic motivation to learn about the modeled environment, but one could imagine a clever instructor building game elements into a lesson plan that features the software and an academic model. Students at all grade levels could be tasked with researching and building their own narrative within the virtual environment; they could be asked to follow the thread of a certain group of annotations and write about the journey; or they could be asked to design their own game that highlights the history of the virtual world.

This isn't your grandfather's type of scholarship. The shift from the single author to team scholarship is a common theme in the Digital Humanities literature, and the call for institutions and disciplines to reward team activities is important, as is the push to teach academics to work successfully on interdisciplinary efforts. This trend impacts the viability of the vision of a VSim project repository and archive insofar as its success requires high-quality content, which in turn requires a significant amount of academic effort. Our user testing thus far suggests that the most desirable content is information-rich environments that can sustain prolonged user interaction (i.e., environments that are highly detailed and/or are fully populated with embedded resources). But building this content takes time, money, and coordination. At question is whether or not scholars (or teams of scholars) will be motivated to generate (and willingly share) the type of 3D content needed to populate the repository. For extant cultural heritage sites, new tools to algorithmically generate 3D geometry from photos or laser scans provide a way to quickly generate computer models that can be adapted for real-time interaction, but these techniques can

¹⁰ Holmes being the real-life serial killer popularized in Erik Larson's "Devil in the White City" (New York: Crown Publishers, 2003).

only capture existing structures or sites.¹¹ For reconstruction projects, where the research is 85% of the task, the computer modeling work is more laborious. The extent to which the levels of labor and skill required for these types of projects makes them academically undesirable is unknown, but it is easy to imagine scholars shunning high-effort projects in favor of activities that produce more immediate results. This emphasizes the need for strategies for developing small-scale projects that will generate impactful scholarship.

Not all 3D research is ideal for secondary scholarship. Successfully building a repository of academically generated 3D content for educational use is predicated on 1) the availability of information-rich content appropriate and desirable for secondary educational use and 2) scholars willing to share their research. Not all 3D content, however, is going to be of interest for secondary use. Trimble's 3D Warehouse boasts 1,956 models in their 'Cathedrals and Churches of the World' category. Sorted by popularity, the top three are Saint Basil's Cathedral in Moscow, Masjid al-Haram in Mecca, and Saint Peter's Basilica in Rome; the last is Chiesa di San Martino Burano in Venice.¹² And there are 1,952 models in between. (Any of these can be downloaded and 'flown' with VSim, provided the content creator has posted the .dae file.) Gauging demand for academically generated content is difficult, but will likely follow a similar pattern – well-known (and commonly studied) structures and environments will be in demand; lesser-known and lesser-studied structures and environments will not. This is potentially problematic if scholars generating content are focused on sites outside the canons celebrated in the survey courses that are VSim's prime audience. In other words, the academics may build the content for their own research and be willing to share, but the end result won't be of use to in-service educators.

Get your @\$@# hands off my data. Intellectual property concerns are a challenge when trying to convince academics to share their research. Speaking from personal experience, it is emotionally difficult to release the results of a significant intellectual effort into the wild. VSim includes a number of features designed to ease content creators' fears about relinquishing control of their intellectual property. Sharing content with VSim does not mean sharing raw files in their native modeling software formats. Instead, VSim loads the raw model files and then exports them into a single binary file for sharing, essentially a read-only file. This approach protects the raw data in so far as it would be difficult for an end user to extract the geometry and use it as the basis for other modeling work. (But there's nothing about VSim that would preclude a content creator from also sharing their raw files.) VSim also allows the content creator to 'brand' their model with content that overlays the simulation window (i.e., they can add a lab logo or a text line about the copyright holder). Content creators can also lock the size of the simulation window (which would limit the quality of 'screengrabs' and improve performance) and restrict user navigation to currently loaded narratives (thereby ensuring that end user only interact with the virtual space as intended by the content creator). Two other user restrictions are intended for the complete version of the software, but have not been implemented in the prototype: the inclusion of an expiration date for the exported files so that content creators can control the life-span of their output (this could be used for projects under development to ensure that users routinely update the content as new work improves the model), and restrictions on the generation of static images and video clips. Part of the planned user testing will be with content creators; of great interest is whether or not these restrictions are enough to address their concerns about sharing their research.

Now you want me to do what? Three-dimensional content alone isn't going to be useful for in-service educators. Expecting an instructor to incorporate an environment into their classroom

¹¹ SVM, 123DCatch, Photoscan, etc

¹² Saint Basil's was modeled by Arrigo Silva, Masjid al-Haram Mecca by Omar, Saint Peter's Basilica by Arrigo Silva, and Chiesa di San Martino Burano by Mario Giudici. (Ranking as of 9/23/2013)
<http://sketchup.google.com/3dwarehouse/cldetails?mid=eb574d9be52eb899cf1885a978e46619&ct=hprl&scoring=p>

without providing context or information about that environment is akin to asking them to lead a walking tour in a foreign city an hour after their arrival. Some level of expert commentary is required in the environment, through some combination of narratives and embedded resources. The embedded resource feature of VSim was designed as a mechanism for annotating the virtual space. The content creator has the power to establish categories of information that make the most sense for their environment (e.g., Site Photos, Architectural Drawings, and Commentary), and resources can be set as local (spatially aware) or global (always available), to auto-launch when the user is within their trigger zone, and/or to auto-reposition the user on launch. Textual information – like explanatory notes and bibliographic references – can be added to the environments as annotations; visual information, such as multi-media files and web resources can be added through the same mechanism. A considerable amount of effort is required to lay in the amount of information required to transform a 3D model into a virtual learning environment. At question is whether that extra level of required effort will limit content creators' willingness to share their research, if only because they won't be willing to expend the effort required to augment their models with this information. One incentive would be to tie the inclusion of this information to the use of VSim for peer review of 3D content. Another option might be to push this work to students, either under the direction of the content creator or as part of an assignment.

Techno-phobia is alive and well. Nothing is more terrifying than standing in front of a lecture hall of undergraduates when the Internet connection goes down, or the projector bulb burns out, or your PowerPoint slide mysteriously crashes. Getting instructors and researchers to interact with 3D content and use it pedagogically is going to be a major hurdle. Before they will embrace VSim, our target instructors need to feel comfortable with the software and trust their navigation skills within the virtual environments. The decision to keep the software on the desktop (vs. online) was purposeful and meant to minimize instructors' concerns about access, stability, and reliability. (This position can be re-visited at the point when web interaction can meet classroom needs.) Again following our 'simple, simple, simple' mantra, we tried to keep the steps to using VSim straightforward. To begin using the software, it needs to be downloaded, unzipped (or in the case of Macs, installed), then launched. To interact with the sample model of the Pantheon, one needs to download the file, 'Open' the model in VSim, select the pre-loaded narrative and press 'play.' Following these simple steps should be feasible for most educators, even the most techno-phobic. Downloading models from the Trimble 3D Warehouse is slightly more complicated: one needs to locate a desirable model in the warehouse, download and unzip the .dae file, 'Open' the model in VSim, and begin navigating. Based on two VSim workshops with post-secondary instructors, the average user can become facile with the navigation modes within ten minutes, less if they're gamers. Of concern is whether in-service instructors will commit the effort needed to learn the software and engage with the 3D content. One strategy to mitigate this concern is to work with TAs to integrate 3D content into discussion sections and use VSim as the basis for student assignments.

Next steps (Phase 2 and beyond)

So much possible user testing, so little time. User testing is ongoing, but confounded by the complexity of the task. The team is actively talking with educators, students, and content creators about their reactions to the general concept, the usability of the prototype software, and their expectations for available content. These user groups may overlap (e.g., a content creator may also be an instructor), but not necessarily. The matrix on the following page illustrates the key questions to be explored with each user group.

	Concept	Software	Content
Instructors and educators	General reactions, thoughts on instructional efficacy, concerns, parameters for use, circumstances for use, and perceived learning benefits/gains	Usability (for both lesson preparation and classroom use), appropriateness for assignments and student work, desirable features, and formative and summative evaluation	Desirable content, outstanding concerns about content (e.g., level of rigor, reconstruction choices, visual fidelity, and latency), and reactions to possible funding models
Students	General reactions, comparison against other instructional technologies, use preferences	General reactions, thoughts on use for assignments, other uses, desirable (and undesirable) features, and formative and summative evaluation	General reactions to content, desirable (and undesirable) features related to content (visual fidelity, latency, etc.), and perceived learning gains
Content creators	Viability; concerns regarding IP, sustainability, and loss of control; desired restrictions; and circumstances under which they would share their content	Desired feature set for subsequent releases, and formative and summative evaluation	Available content, information about file formats and desired loaders, and exploration of willingness to annotate and share content
All test users	Functionality, usability, desired program modifications, reproducible bugs, most used features in current release, narrative creation process typically used, desirable features in next release, and the usability of training documents and videos		

An experiment in peer review of 3D content. Beyond pedagogical applications, the project team is also working to test the use of VSim for the peer review of 3D content. VSim PI Snyder and Dr. Elaine Sullivan – now on faculty in the Department of History at the University of California, Santa Cruz – are working with Anvil Academic, a publisher of born-digital academic research, to annotate and release an interactive model of the Egyptian temple complex of Karnak that links to the NEH-funded teaching and learning resources posted on the Digital Karnak website. For this proof-of-concept test, the Karnak team is producing an article describing VSim and its use for dissemination and pedagogical use of 3D content, and the annotated real-time model complete with embedded resources and a suite of narratives about the virtual environment. For their part, Anvil will recruit, guide, and oversee a team of reviewers expert in Egyptology, art history, architecture history, digital humanities, and educational technology to provide peer review of the project materials. Reactions to this experiment will help guide future VSim efforts.

The top ten list of changes for the prototype. A ‘wish list’ for additional features to be included in subsequent releases of VSim is already being assembled based on user feedback and our own internal testing. It should be noted, however, that work on the specifications for Phase 2 will only commence in earnest upon procurement of additional funding. Desired modifications include:

- expansion of the ‘show all’ feature of the embedded resources (the visual display is cumbersome when there are hundreds of resources);
- addition of overlay scaling on window resize;
- an elapsed timer for narrative playback;
- the addition of loading capabilities for other 3D file formats;

- expansion of the controls for the narrative transitions;
- expansion of the image and movie capture functionality;
- the addition of physics-based effects such as water, real-time shadow casting, and lighting;
- compression algorithms for the binary files;
- inclusion of a ‘paths’ mechanism to facilitate complex narratives;
- and a provision for the use of spreadsheets to allow for temporal changes to models built with Sketch Up models (currently available only for models built with Creator).

Conclusions

Was the prototype development process worth the effort? Definitely. Positive user reactions to the software and UCLA computer models have validated the project’s larger vision and reinforce the idea that engagement with 3D content can provide significant opportunities for innovative pedagogy and learning benefits.

But what about all of the challenges and issues just discussed? Some of those will resolve themselves with time. The trajectory of software development in the for-profit world, for example, will continue to shape the direction of academically generated 3D projects, but in a technological survival of the fittest, toolsets and software platforms that are simple, versatile, and efficient will be embraced; lesser-used technologies will fade away. Eventually a standard toolkit will emerge and there will be a role for VSim in that mix insofar as it addresses a specific set of research, teaching, and learning objectives. Some of the challenges and issues described fall into the ‘damned if you do and damned if you don’t’ category. Project teams will face long-term sustainability issues regardless of their development choices. The question to include gaming opportunities, avatars, and social media may best be answered by identifying other tools and platforms that already accommodate those functionalities. Better to focus on a clear objective than to try to be all things for all scholars.

The remaining challenges and issues are the roadmap for the project team’s next steps. Only user testing and discussions with educators, content creators, and students will provide answers to the many of the concerns expressed above. Is the software simple enough for educators to embrace? Probably, given the right training materials and available content. Will academics continue to build 3D content? Yes, given that the task maps to their current research questions. Will they be willing to share their models for educational use? Probably, given the right combination of incentives and control over their intellectual property.

Which returns us to our original question. What will it take to realize the larger project’s vision? Commitment. Energy. Time. Talent. Coordination. Marketing. Buy-in. Funding.

If you are interested in working with VSim or making your own 3D content available for educational use, please contact Lisa M. Snyder at UCLA’s Institute for Digital Research and Education (lms@idre.ucla.edu).

The UCLA VSim project team

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